VENTILATION ACTIVITY AND GUT FULLNESS OF THE BURROWING GHOST SHRIMP, *CALLIANASSA AUSTRALIENSIS* DANA (DECAPODA: CALLIANASSIDAE), DURING LOW TIDE

Invertebrates that live in deep burrows in the intertidal zone are thought to gain an advantage by being insulated from environmental changes at low tide. Stress causes many intertidal invertebrates to cease feeding at some time of the tidal cycle (Newell, 1979). The shrimp, *Callianassa australiensis* feeds in burrows but may possibly change its feeding activity at low tide. This study aimed to detect and quantify changes in behaviour that may help explain the role of the tide in the feeding energetics of this species.

Methods and Materials

The study site was located on One Mile Beach on North Stradbroke Island, (27°29'S, 153°24'E). The oxygen tension of burrow water samples was determined using a portable oxygen meter and magnetic stirrer. Animals were collected by using a 'yabby pump' at different times after the tide had uncovered their burrow apertures. General physiological and morphological data collected included, sex, wet weight, carapace length, moult state, and 'empty' or 'not-empty' state of the gut of each shrimp was recorded. In one group of animals (T = 0h n = 43, T = 2h n = 38) the fresh and dry weight of the foregut and 'intestine' was obtained after dissection. The temperature of mud (30cm depth) and surface puddles were recorded in conjunction with each sample of shrimps.

Results and Discussion

The shrimps ceased ventilating and purging sediment from their burrows 2–3h after low tide. The oxygen tension of water samples taken from the burrows fell significantly at low tide, from 19.98± 1.25 kPa at 0h (N = 8) to 12.04±3.01 kPa, (N = 10, P<0.05) after 1h, but there was no further change after 3h (13.58±4.72 kPa, N = 10, P>0.20). Large amounts of oxygen were therefore available for respiration by these shrimps at low tide. Warming of the sediment during daylight low tides was less marked (at about 30cm depth, in the order of 1–2°C) than the rapid warming found in puddles on the surface of the mudflat (7–8°C). At least some shrimps pump this warm surface water through their burrows at low tide.

No significant change in wet or dry foregut weight could be detected, however, the mass of the intestines of shrimps collected after 2h of low tide was lower than that of shrimps collected at the beginning of low tide, (Mann Whitney test applied to wet weights, Z = -3.937, N1 = 43, N2 = 38). The mean percentage (prior to arcsine transformation) of the population with 'empty' intestines increased at low tide (data from 7 tides), from 5.36±6.19% to 47.51±20.44% within the first hour (using arcsine transformed data, t = -4.9058, DF = 12, P<0.0005), before levelling off (t = 2h 61.87±20.04%, t = 3h 64.00±16.83%). This change was reflected also in shrimps captured in the act of burrow ventilation/sediment purging during several low tides (pooled data, T = 0, N = 78 empty 0%; T = 1–2h, N = 65, empty 50.8%), indicating that sediment purging (with associated thermal stress) was not confined to shrimps containing faecal pellets. The decline in sediment purging behaviour at low tide occurred in parallel with, and cannot therefore be explained by, changes in gut fullness, i.e. 'feeding' activity.

Knowing the relationship of 'empty' intestine weight (log (W) = 3.736 log (L) - 3.145, N = 28, r^2 = 0.55, F = 329.8 P<<0.001) and 'not-empty' intestine weight (log (W) = 2.424 log (L) - 1.084, N = 53, r^2 = 0.67, F = 105.0, P<<0.001) to carapace length (L) allows mean faecal pellet egestion rates to be calculated. Roughly half of the population empties their intestines in the first hour of low tide, requiring those shrimps to egest faeces at 11.08 and 26.51mg wet faeces h^{-1} for shrimps with a carapace length of 8 and 12mm respectively. This result compares well with the data obtained by Frankenberg *et al.* (1967) from faecal pellets discarded by *Callichurus major* at low tide, (50.6mg wet faeces burrow $^{-1}$ h^{-1}).

A large portion of the shrimp population clears faeces from their intestines during low tide and may very well cease feeding at this time. Further work is required to establish why some shrimps fail to empty their gut and to explain the variation in response between tides.

Literature Cited

Frankenberg, D., Coles, S.L. and Johannes, R.E. 1967. The potential trophic significance of *Callianassa major* fecal pellets. Limnology and Oceanography 12: 113–120.

Newell, R.C. 1979. 'Biology of intertidal animals'. 3rd Ed. (Marine Ecological Surveys Ltd: Faversham, U.K.).781p.

Brian D. Paterson, Queensland Food Research Laboratories, Queensland Department of Primary Industries, Hamilton, Queensland 4007, Australia.